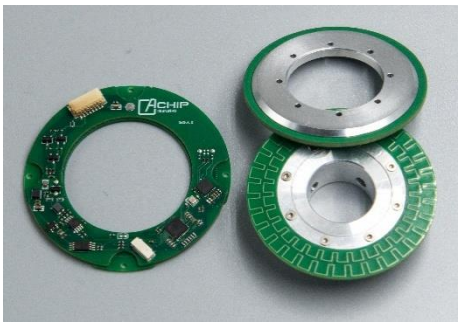
ED-S060 Large and medium hollow inductive absolute position encoder module manual



ED-S060 large and medium hollow inductive absolute position encoder

product features

- Inductive absolute position encoder
- Maximum speed 8000 rpm
- 19 bits, resolution
- Self-calibration function, can be calibrated twice (refer to), absolute accuracy <0.01 °
- Not affected by oil pollution, dust, moisture, high and low temperature and other pollutants
- Immune magnetic interference
- It's extremely light
- Suitable for robots, CNC machine tools and automation systems
- It can be off-axis and through the axis, and is easy to install
- Supports RS485 communication protocol

key parameter	
Sensor type	Inductance type, single-turn absolute angle encoding (provides multi-turn solution)
Output type	8-pin PCB connector, 1mm spacing
Market equipment	Industrial servo motor, robot, automation system, etc
size	The outer diameter of the encoder is 60 mm ± 0.1 mm, and the maximum inner diameter is 37 ± 0.1 mm

Electrical parameters	
parameter	ED-S060
service voltage	5 V ± 5%
Supply current @5V	60 mA
output interface	RS485
Output Angle	0-360°
accuracy @25 °C	≤0.01°
Output noise (gap 1 mm, 25 °C)	± 1 LSB
resolution ratio	19 bits (effective value)
Power on time	≤ 100 ms
transmission delay	≤ 15 μs
Angle update rate	≤ 16 kHz (RS485, 2.5Mbps)

Mechanical specifications (all versions)	
parameter	
The mechanical angle	360°
maximum speed	8000 rpm
rotor weight	≤ 5.5 g
Stator weight	< 10 g

Environmental performance parameters	
parameter	
operating temperature range	-40 °C to +125 °C
Storage temperature range	-40 °C to +125 °C
humidity	Less than 80% no condensation, no dew
protect	PCB component surface three-proof paint coating
Shaking conditions	0.05g2/Hz, subjected to vibration along the three axes at frequencies from 20 Hz to 2000 Hz for one hour
Conditions of shock	100g,6ms, half sine

Main EMC parameters and standards			
parameter	**standard**	**grade**	**explain**
Electrostatic discharge immunity (ESD)	61000-4-2 :2008	Level 4 (8 kV, contact discharge)	The equipment can withstand 8 kV contact discharge (only at the connector interface)
Radiation resistance of radio frequency electromagnetic field (80 MHz to 6 GHz)	EN 61000-4-3:2020	Level 3 (10 V/m)	The equipment can still work under the radio frequency field strength of 10 V/m
CISPR (150 kHz to 80 GHz)	EN 61000-4-6:2014	Level 3 (10 V)	The equipment is resistant to 10 V conduction interference (such as RF noise coupled by power lines).
Power frequency magnetic field immunity (50 Hz)	EN 61000-4-8:2010	Level X (1500 A/m, 2 mT)	The equipment can withstand strong power frequency magnetic fields (such as near transformers), and grade "X" indicates that it needs to be defined according to the actual application scenario.
Radiation emission (30 MHz to 1 GHz)	EN 55011	Class A Group 1 (industrial environment (1))	The equipment has low electromagnetic radiation in the industrial environment and complies with industrial equipment standards

pay attention to

? The above EMC levels comply with EN IEC 61326-1 and are suitable for industrial environments.

? No overvoltage protection is integrated: The device does not include protective measures for switching transients or lightning transients (standard 61000-4-5). An external protection device (such as a surge protector) is required. To reduce risks, it is recommended that the power cord be no longer than 3 meters to minimize the risk of conducted interference, and the data cable be no longer than 30 meters to reduce signal attenuation and noise coupling.

(1) Applicable environment: The equipment is designed for industrial environment and is not suitable for residential areas (may interfere with radio equipment).

Other information



pay attention to !

Precautions for handling electrostatic sensitive equipment!

Warning: When installing or replacing the sensor, the serial number of the rotor and stator must be consistent!

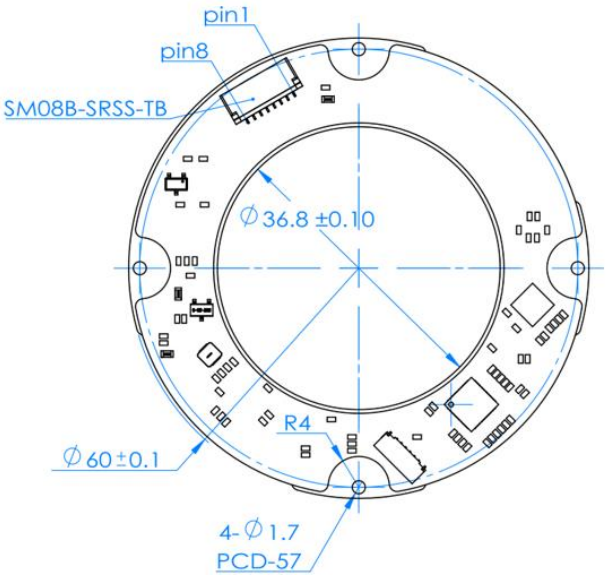
? The sensor is delivered in an anti-static package and can only be removed from the anti-static bag within the electrostatic protection area (EPA).

? Do not damage the surface of the rotor.

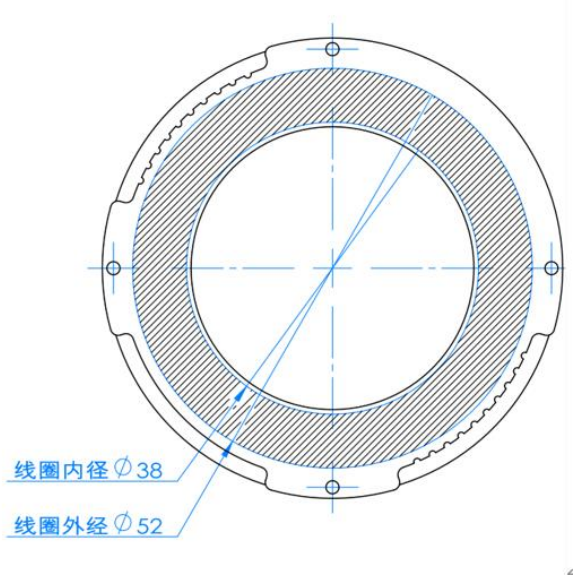
? Do not use cleaning products or chemicals.

? Environmental protection: When used in heavy load environment (such as metal particles, oil, grease, salt spray, moisture, corrosion, etc.), protective coating or potting can be used according to requirements.

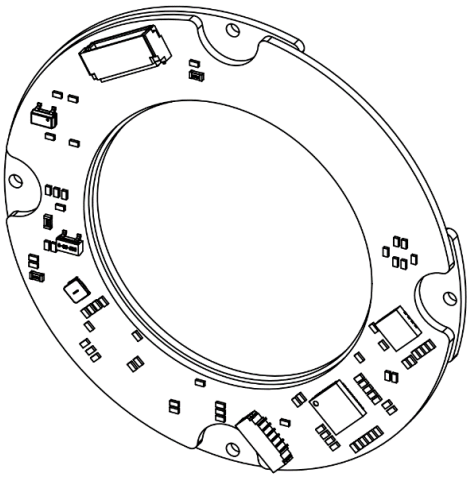
1 Encoder stator size

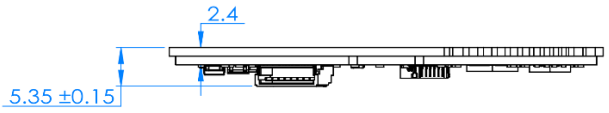


front



the back



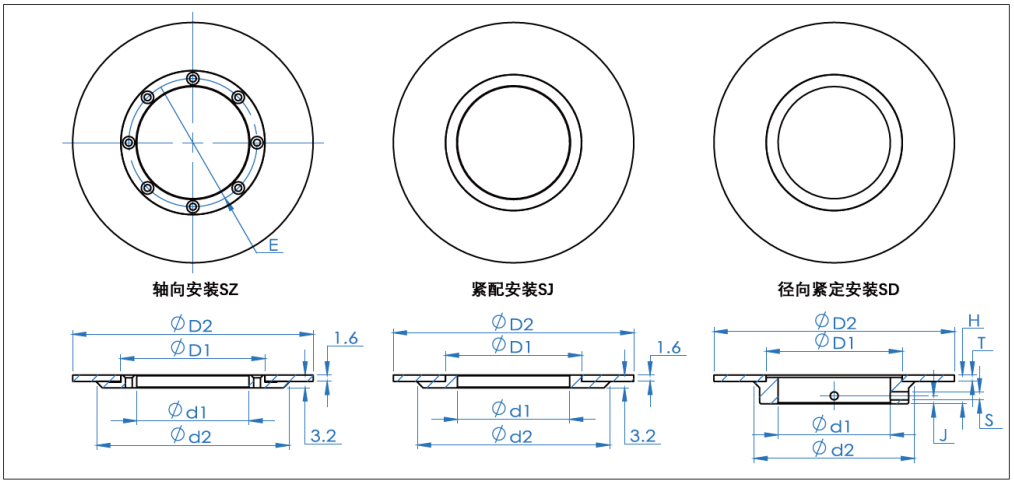


side

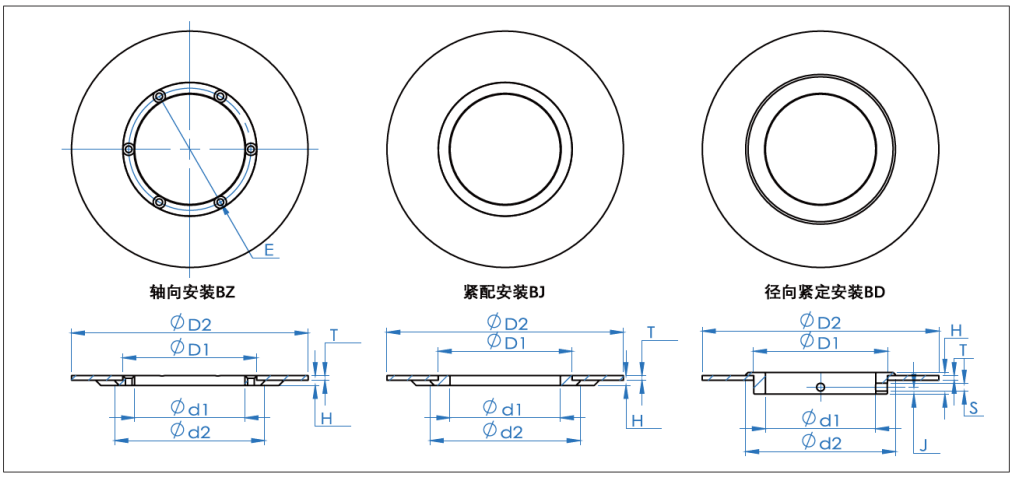
Stator appearance

2 Encoder rotor size and installation method

转子-标准款



转子-超薄款



Rotor size (mm)											
type	way to install	d1	d2	D1	D2	T	H	E	K	J	S
Standard model	axial mount -SZ	28+0.02	48	36	60	1.6	3.2	32	M1.6 countersunk hole	-	-
	Close fit installation-SJ	28–0.02	48	34	60	1.6	3.2	-	-	-	-
	Radial installation-SD	28+0.02	40	34	60	1.6	7.2	31	M1.6 countersunk hole	2	2*M2.5 P0.45
Ultra-thin	axial mount -BZ	28+0.02	38	34	60	1.2	2.5	31	M1.6 countersunk hole	-	-
	Close fit installation-BJ	28–0.02	38	34	60	1.2	2.5	31	M1.6 countersunk hole	-	-
	Radial installation-BD	28+0.02	38	34	60	1.2	5.5	31	M1.6 countersunk hole	1.75	2*M2.5 P0.45

Axial installation (SZ, BZ):

Use the 28mm inner ring of the rotor as the positioning reference, and end face 8-M1.6 countersunk screw (S1 type) or 6-M1.6 countersunk screw (L1 type). This installation method usually determines the Airgap.

Close fitting installation (SJ, BJ):

The body is thin, and the inner circle of the rotor has negative tolerance. It can be installed by interference or pressed with a central internal thread ring. If bonding is required, please design a glue groove on the shaft, with a diameter 27.6mm and a width of 1mm.

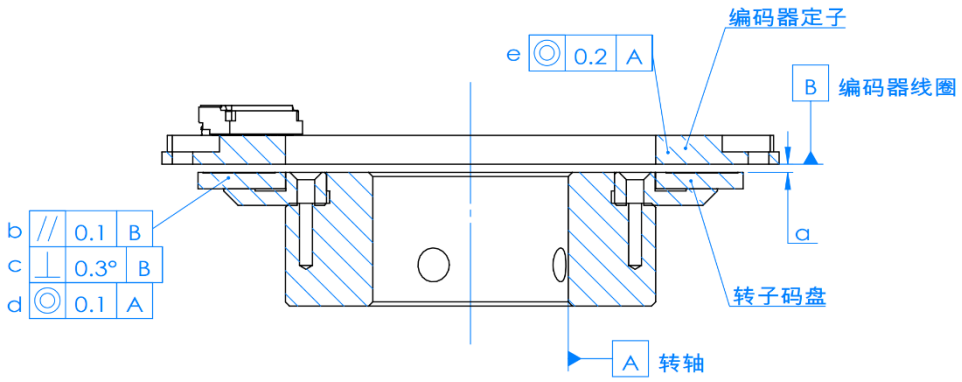
Radial installation (SD, BD):

This model comes with 2 M2.5 radial set screws, which can be directly tightened and installed after the shaft is inserted. This type of code disk is usually thick, but the Airgap can be adjusted.

3 requirement of assembling

The installation error is illustrated in the figure below. The code disk is mounted on the rotating shaft, and the installation error significantly affects the precision during operation. Particularly, the skew of the b code disk and the eccentricity of the d rotor directly impact the encoder's absolute positioning accuracy. The error b primarily results from the shaft bending or the code disk mounting surface not being perpendicular to the shaft. The error d typically occurs during assembly, and it is essential to use jigs or other high-precision inspection methods to minimize installation errors when installing the rotor code disk.

The core encoder uses self-developed sensor chip to read inductive data, and the inherent compensation algorithm is used to achieve a more tolerant difference range. Among them, the a c e error mainly affects the signal strength and linearity, which can be compensated to a certain extent through self-correction.



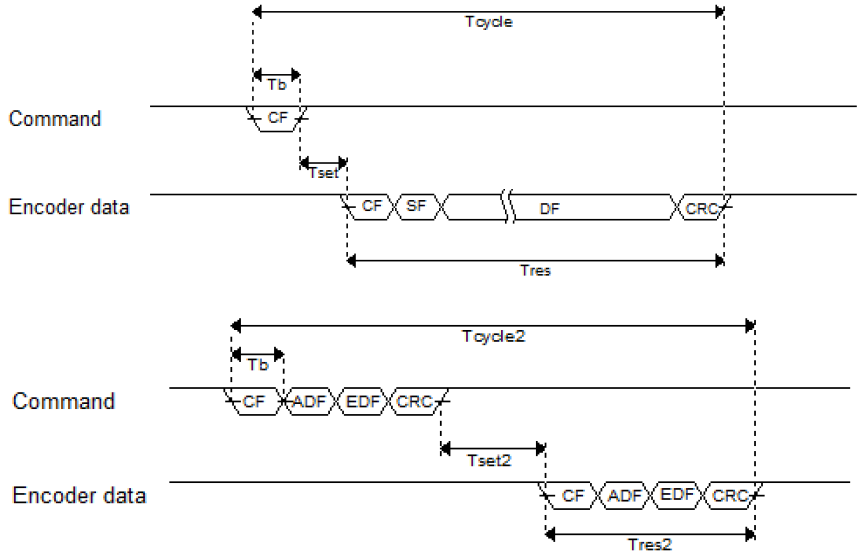
Encoder installation example section

A list of allowable errors for installation					
position	type	standard value	scope	unit	explain
a	Air gap (air gap)	0.8	±0.2	mm	Axial distance to be guaranteed during static installation
b	deflection (sk-ew)	0	0.1	mm	Maximum axial swing range during rotor rotation
c	Axis tilt (tilt)	0	0.3	degree	The encoder stator plane is not perpendicular to the shaft
d	Wobbling	0	0.1	mm	Radial installation error between rotor code disk and shaft
e	Off-axis (eccent-ric)	0	0.2	mm	Radial installation error between encoder stator and shaft
A	reference axis				Shaft-concentricity measurement reference
B	base level				Encoder surface coil-oscillation/tilt measurement reference

4 CI

This product uses the RS485 communication interface protocol, with a data communication baud rate of 2.5 Mbps, 8 bits per data bit, no parity check, and one stop bit. The angle data bit width can be configured from 17 to 23 bits, with the default being 23 bits. To ensure strong EMC immunity, it is strongly recommended to use twisted pair cables, such as the A and B signal lines in the RS485 communication interface

Signal lines should be twisted pairs. Power signals (VCC, GND) do not require twisted pairs. The typical impedance of signal lines is 120 Ω, and the requirements for the termination resistor depend on the total length of the communication bus and the communication speed used. The encoder has a 120 Ω impedance-matching resistor.



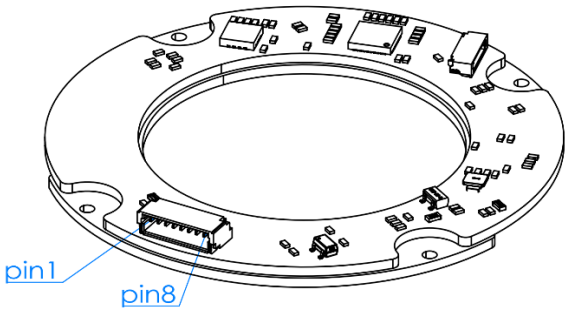
Read and write data transmission format

4.1 protocol specification

unit	description	explain
CF	Control Field	Different types of commands
SF	Status Field	Different encoder states
DF	Data Field	Encoder position data
ADF	Address Field	Operable address
EDF	E2PROM Field	Operation address content
CRC	CRC verification	Polynomial X8+1 (all data XOR except CRC)

5 Connector type

The communication interface connector installed on the ED-S060 is SM08B-SRSS-TB, which has a total of eight pins. The pin sequence and definition are shown in the figure below and the table below. Customers can select the wiring of the connector according to the table below.



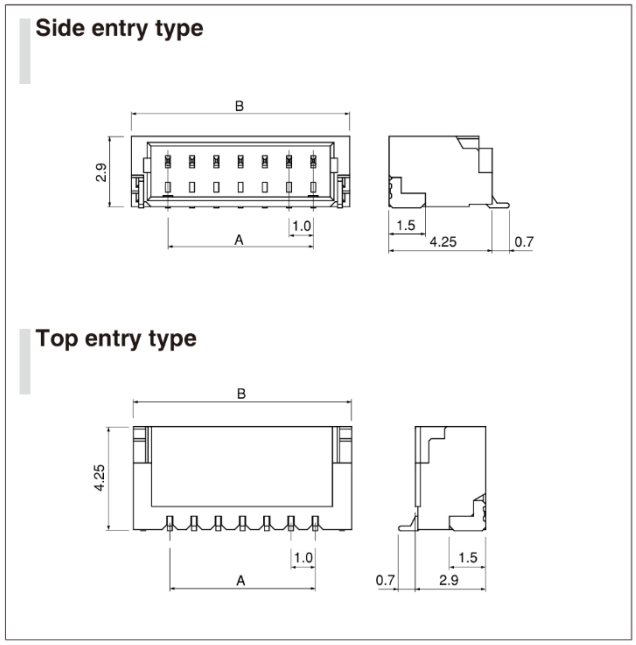
Output port pin sequence

RS485 communication protocol				
Pin num-ber	definition	description	type	Optional: connector wiring (Cable connector type: SM08B-SRSS-TB)
1	NC	Not defined	Pull up pin	purple
2	NC	Not defined	Pull up pin	Citrus sinensis
3	A	RS485, data transmission line	Output pin	yellow
4	B	RS485, data transmission line	Output pin	hispid arthraxon
5	NC	Not defined	Pull up pin	white
6	NC	Not defined	Pull up pin	blue
7	VCC	power input	Power pin	red
8	GND	the earth	Power	black

Communication interface connector pin definition

5.1 Connector size

The connector type is SM08B-SRSS-TB.



Circuits	Model No.		Dimensions (mm)		Q'ty / reel	
	Top entry type	Side entry type	A	B	Top entry type	Side entry type
2	BM02B-SRSS-TB	SM02B-SRSS-TB	1.0	4.0	1,500	3,000
3	BM03B-SRSS-TB	SM03B-SRSS-TB	2.0	5.0	1,500	3,000
4	BM04B-SRSS-TB	SM04B-SRSS-TB	3.0	6.0	1,500	3,000
5	BM05B-SRSS-TB	SM05B-SRSS-TB	4.0	7.0	1,500	3,000
6	BM06B-SRSS-TB	SM06B-SRSS-TB	5.0	8.0	1,500	3,000
7	BM07B-SRSS-TB	SM07B-SRSS-TB	6.0	9.0	1,500	3,000
8	BM08B-SRSS-TB	SM08B-SRSS-TB	7.0	10.0	1,500	3,000
9	BM09B-SRSS-TB	SM09B-SRSS-TB	8.0	11.0	1,500	3,000
10	BM10B-SRSS-TB	SM10B-SRSS-TB	9.0	12.0	1,500	3,000
11	BM11B-SRSS-TB	SM11B-SRSS-TB	10.0	13.0	1,500	3,000
12	BM12B-SRSS-TB	SM12B-SRSS-TB	11.0	14.0	1,500	3,000
13	BM13B-SRSS-TB	SM13B-SRSS-TB	12.0	15.0	1,500	3,000
14	BM14B-SRSS-TB	SM14B-SRSS-TB	13.0	16.0	1,500	3,000

Material and Finish
Contact: Copper alloy, copper-undercoated, tin-plated (reflow treatment) Wafer: PA, UL94V-0, natural Solder tab: Brass, copper-undercoated, tin-plated (reflow treatment)

RoHS compliance *This product displays (LF)(SN) on a label.*

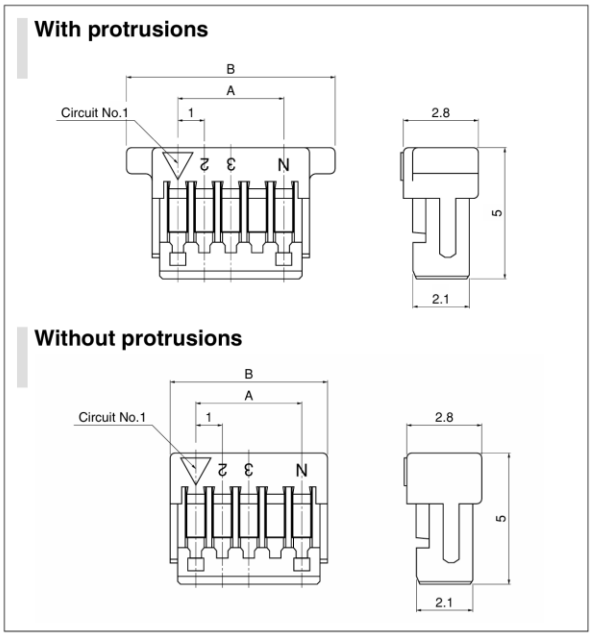
Note: 1. The products listed above are supplied on embossed-tape.

2. Contact JST for the top entry type headers with suction cap.

Connector size diagram

5.2 Recommend the specifications of the plug-in terminals

Recommended plug-in terminal SHR-08V-S-B.



Circuits	Model No.		Dimensions (mm)			Q'ty/ box
			A	B		
	With protrusions	Without protrusions		With protrusions	Without protrusions	
2	SHR-02V-S-B	SHR-02V-S	1.0	5.0	3.0	2,000
3	SHR-03V-S-B	SHR-03V-S	2.0	6.0	4.0	2,000
4	SHR-04V-S-B	SHR-04V-S	3.0	7.0	5.0	2,000
5	SHR-05V-S-B	SHR-05V-S	4.0	8.0	6.0	2,000
6	SHR-06V-S-B	SHR-06V-S	5.0	9.0	7.0	2,000
7	SHR-07V-S-B	SHR-07V-S	6.0	10.0	8.0	2,000
8	SHR-08V-S-B	SHR-08V-S	7.0	11.0	9.0	2,000
9	SHR-09V-S-B	SHR-09V-S	8.0	12.0	10.0	2,000
10	SHR-10V-S-B	SHR-10V-S	9.0	13.0	11.0	2,000
11	SHR-11V-S-B	SHR-11V-S	10.0	14.0	12.0	2,000
12	SHR-12V-S-B	SHR-12V-S	11.0	15.0	13.0	2,000
13	SHR-13V-S-B	SHR-13V-S	12.0	16.0	14.0	2,000
14	SHR-14V-S-B	SHR-14V-S	13.0	17.0	15.0	2,000
15	SHR-15V-S-B	SHR-15V-S	14.0	18.0	16.0	2,000
20	SHR-20V-S-B	—	19.0	23.0	21.0	1,000

Material
PBT, UL94V-0, natural (white)

RoHS compliance

Recommend the specifications of the plug-in terminals

6 Typical encoder workflow

The encoder is factory mode by default. The typical workflow of the encoder is as follows:

1. First, initialize the direction configuration and configure the rotor direction.

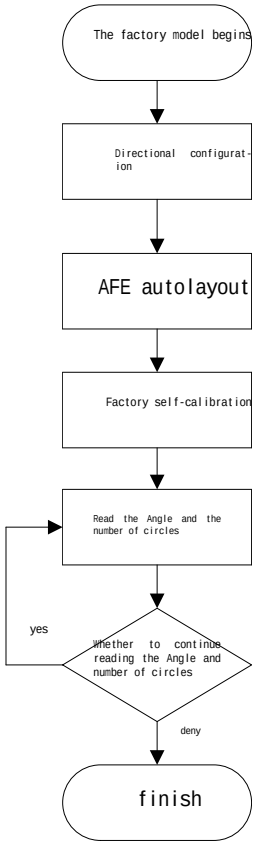
2After the initialization configuration is completed, the front-end gain configuration is performed. For details, please refer to the automatic configuration workflow of the analog front end.

3. After the front-end automatic configuration is completed, self-calibration configuration is performed. For details, please refer to the self-calibration configuration workflow.

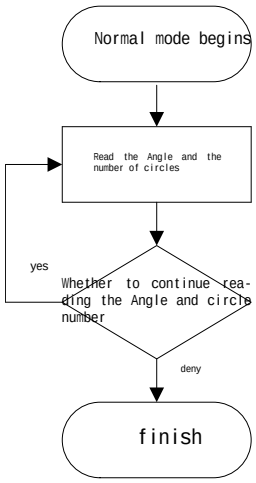
4After the above configuration is completed, the configuration encoder enters the normal working mode.

5、 Wait for the Angle and circle data to be read.

6. Read the encoder Angle and circle number data. If the board is re-powered, you can start working directly from step 5, and the configuration of steps 1-4 will remain the last configuration.



Factory pattern flow chart



Normal mode flowchart

Typical encoder workflow

7 Command summary

The chip has two working modes: factory mode and normal mode. The factory mode is entered by default when the chip leaves the factory, and it will switch to normal operation mode only after the corresponding registers are set after calibration. When switching modes, the chip needs to be powered off and restarted.

work pattern	function	explain
The factory model	Configure the front end in simulation mode	The configuration TX amplitude is out of balance with the AFE gain
	self calibrate	Calibrate non-ideal factors
	Angle direction setting	Set the rotation direction
	Extreme logarithmic configuration	The logarithm of the number of pairs for many and few pairs
	Work mode switch	Switching between factory mode and normal mode
	Set the device Unique_ID	Set the user ID
Normal operation mode	Read the Angle and circle information	Read the single and multiple circle angles
	Read the Angle information	Read the single circle Angle
	Set the zero position Angle	Set the current position to zero

function	order	remarks
Switch the factory mode	7E FF FF 7E	Restart takes effect
Switch to normal mode	7E 1A 1A 7E	Restart takes effect
Configure the number of coil poles	5E + 1Bytes Data1 + 1Bytes Data2 +CRC	Data1: Multi-pole pair logarithm Data2: Fewer poles to poles 0x01:1 pole pair 0x02:2 poles … 0xFF: 255 polarity pair
Set the orientation of the configuration	5E + 1Bytes Data1 + 1Bytes Data2 +CRC	Data1: Multi-pole pair logarithm Data2: Fewer poles to poles 0x00: clockwise 0x01: counterclockwise
Read the Angle and number of turns	1A	
Read the Angle information	02	
Set the zero position Angle	C2	Set the current position to zero

8 Simulation of front-end automatic configuration

After the encoder module is reinstalled, due to changes in the air gap between the rotor and stator, the analog front end (AFE) must be recalibrated to ensure that the ADC's analog output meets performance requirements. The encoder supports sending a command via the serial port to trigger the automatic configuration process of the AFE, achieving rapid calibration (within 1 second). Throughout this process, the rotor must be in rotation and should operate at a low speed (up to 50 rpm).

Configuration command: 0x0A 0xFE 0xF4;

Command description

Send command: 0x0A 0xFE 0xF4;

receiving order ：

AFE configuration success: 0x0A 0xFE 0xF4;

AFE configuration failed: 0x0A 0xFF 0xFF;

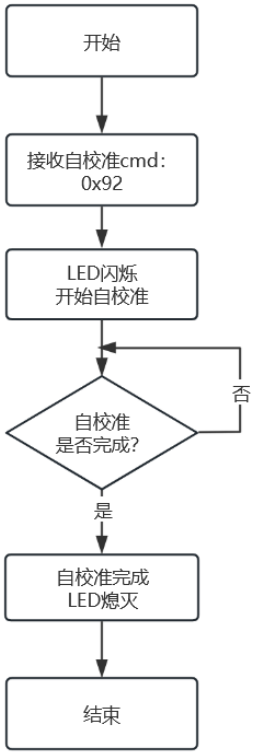
autolayout AFE		
cell	**description**	**explain**
0x0A 0xFE 0xF4	Send instructions	Enable automatic AFE configuration
0x0A 0xFE 0xF4	Receive instructions	The configuration AFE is successful
0x0A 0xFF 0xFF	Receive instructions	Configuration of AFE failed

9 self calibrate

Ideally, the rotor and stator of an encoder are perfectly aligned, with no installation issues such as eccentricity or tilt. However, in real-world applications, mechanical installation errors between the stator and rotor, such as eccentricity and tilt, can significantly impact the encoder's performance. The encoder module supports self-calibration during the downstream product development phase, which helps eliminate signal misalignment and matching errors caused by installation tolerances. Additionally, self-calibration can also address non-ideal factors like amplitude mismatch, misalignment, phase misalignment, and code channel zero point misalignment.

To ensure the effectiveness of the self-calibration function, the following conditions must be met during calibration: the rotor must be in a rotating state and should complete the process at a low speed (≤50 rpm). This ensures that the chip can accurately calculate and generate effective calibration parameters. The self-calibration process can be completed at either a constant or non-constant speed, without the need for precise control of the motion, thus significantly reducing the complexity and difficulty of encoder calibration.

The self-calibration process is illustrated in the figure below: The host computer sends a self-calibration command to the chip. Upon receiving the command, the indicator light starts to flash, and the calibration process begins. Throughout the calibration, the rotor must remain in rotation, ensuring that the rotation angle exceeds one mechanical cycle. Once the chip has automatically completed the calculations and updates, it writes the results to the designated address. At this point, the indicator light turns off, and the serial port returns a value of 0x92, indicating that the self-calibration is complete.



Self-calibration process

Self-calibration command description

Command: 0x92; self-calibration command.
Return value: 0x92; return value for calibration completion.

Self-calibration command		
cell	**description**	**explain**
0x92	Command type	Self-calibration command

10 Register configuration list

Configuration registers			
address	**register**	**name**	**explain**
0x0000FE00	[31:0]	ZeroShift	Zero position Angle data
0x0000FE04	[31:0]	Mode	Mode switching
0x0000FE08	[15:8]	MultNum	Multi-pole coil pole number
	[8:0]	MinNum	The number of poles is less than the number of coil poles
0x0000FE0C	[31:0]	Direction	Rotate the angle in a clockwise direction
0x0000FE10	[95:0]	ID0	Device unique ID
0x0000FE14		ID1	
0x0000FE18		ID2	

11 Instruction instructions

11.1 Location data read

CF type	description	explain	Number of bytes	remarks
0x1A	Read all the data	CF (0x1A) + SF (1Byte) + DF (3Bytes Angle) + ID + ABM (3Bytes turns) + ALMC (Encoder fault bit) + CRC (XOR checksum)	11Byte	DF: low first, high later ABM: low in front and high behind
0x02	Absolute position information reading	CF (0x02) + SF (1Byte) + DF (3Bytes) + CRC (XOR checksum)	6Byte	DF: low first, high later
0xC2	Set the zero position Angle	CF (0xC2) + DF (3Byte Angle)	4Byte	DF: low first, high later

Command description: 0x1A:

for instance ：

Send: 0x1A

Receive: 0x1A,0x00,0x56,0x34,0x12,0x17,0xFF, 0xFF, 0xFF, 0x00, CRC CF: 0x1A;

SF： 0x00；

DF： 0x56，0x34，0x12；

ID： 0x17;

ABM： 0xFF，0xFF，0xFF；

ALMC： 0x00；

CRC: CRC (xor parity of all bytes except CRC);

Command description: 0x02:

for instance ：

Send: 0x02

Receive: 0x02,0x00,0x56,0x34,0x12, CRC

CF： 0x02;

SF： 0x00；

DF： 0x56，0x34，0x12；

ALMC： 0x00；

CRC: CRC (xor parity of all bytes except CRC);

Command description: 0xC2:

for instance ：

Send: 0xC2

Receiving: 0xC2, 0x56,0x34,0x12;

CF： 0xC2;

DF： 0x56，0x34，0x12；

CRC: CRC (xor parity of all bytes except CRC);

11.2 Read and write FLASH data format

Command and protocol format timing parameters					
sign	least value	representative value	crest value	description	unit
Tcycle	51			RS485, read data cycle	μs
Tcycle2	35 or 94			RS485 write Flash instruction cycle 35 μs@ Address/data preparation 94 μs@Flash write	μs
Tb		4		Single Byte, transmission time	μs
Tset	3	3		Encoder response time to CF command	μs
Tset2	3 or 62			Returns the time required for the instruction response data 3 μs@ Address/data preparation 62 μs@Flash write	μs
Tres		4*N		The encoder reads the data and returns the total duration of the frame. N represents the number of bytes returned	μs
Tres2		32		The encoder writes the Flash return frame duration	μs

11.3 The protocol format for reading data from a specific address memory or register

Read data transmission protocol frame description:

unit	description	explain	Number of bytes
CF	Control Field	Command frame header (0x5C)	1Byte
ADD	Address	4Bytes address (Addres[31:24]... Addres[7:0])	4Byte
CRC	CRC verification	Polynomial X8+1 (all data XOR except CRC)	1Byte

The protocol frame indicating the successful return of data is read:

unit	description	explain	Number of bytes
CF	Control Field	Command frame header (0x5C)	1Byte
ADD	Address	2Bytes address Addres[15:8] + Addres[7:0]	2Byte
	Data	4Bytes of data (Data[31:24]... Data [7:0])	4Byte
CRC	CRC verification	Polynomial X8+1 (all data XOR except CRC)	1Byte

The read data failed and returned the protocol frame description:

unit	description	explain	Number of bytes
CF	Control Field	Command frame header (0x5C)	1Byte
ADD	Address	2Bytes address Addres[15:8] + Addres[7:0]	2Byte
STA	State	0x02: CRC error; 0x03: Request command exception; 0x04: Exception address;	4Byte
CRC	CRC verification	Polynomial X8+1 (all data XOR except CRC)	1Byte

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